depends upon the local influences to which the changing masses may be subject. The coral polypes, building their stupendous edifices within the waters of tropical seas, consolidate as they form the outer or barrier reef, as limestone rock; every succeeding generation of these minute existences contributing, during life and in death, by the addition of its organic body, to the increase of the general mass. Other species decompose and fill up the valleys and troughs with ocean marls, uniting with shell-fish and the relics of the myriads of the deep thus locally disposed. These submarine mountain ranges of limestone, embracing in their consolidated state the reliquæ of countless species, are analogous to many of the limestone ranges composing the British strata, the latter having manifestly been produced under the same influences. From this one fact we learn that limestone forms, under certain conditions, in sea-water; and that so long as these conditions exist, and it maintains its local position and influences, so long will it maintain its aggregated masses unimpaired: but, although this is one Cause of a manifest Effect, we must not thence infer that it is the sole cause, for there is no other class of rock which forms under such a variety of aspects. The calcareous masses, when abstracted from the element which gave them being, and exposed to the local action of intense atmospheric heat, change according to the accident of association, becoming converted into sulphate of lime or gypsum, carbonate of lime or common brown limestone, and, with the addition of water, into marbles of varieties. A dry heat, and the saline waters of the ocean are, therefore, both favourable for forming limestone rock; heat and moisture are favourable for the generation of marbles, and under these influences the finest marbles of the world are produced. In acquiring this knowledge we are, therefore, enabled to apply it to practical purposes in those regions where it is formed, with the surety that the same causes which produced it, will, so long as they continue in action, preserve it from the ravages of time. The ancient Egyptians used limestone largely in the building of their mighty pyramids, in their palaces and temples; and the catacombs are invariably formed in this material, the hills bounding the upper portion of this country being wholly calcareous. They are still, many of them, in their several stages of transition from a soft carbonate, resembling chalk, to the most ponderous brown limestone rock; and the beds in which the catacombs are disposed are, even now, where sealed from atmospheric influences, in this condition, being of a dazzling whiteness, uniform in composition and character, and hardening by long exposure to the atmosphere. As we approach the northern hemisphere we still find that the calcareous beds pass, by gradual transition, into limestone, embracing numerous varieties; but the conditions of change now vary, the change being effected by chemical action generated within the lower beds, and all kinds corroding on exposure to atmospheric air. In the British strata we find numerous species of calcareous rocks, many of which have been formed by causes now no longer in existence in this country; but few of them, without the influence of the atmosphere for any considerable length of time, can wisely be applied to buildings which it is proposed shall laugh to scorn the ravages of Time, and those few are confined to those compound rocks termed magnesian limestone. The presence of calcareous matter in any considerable quantity is to be deprecated, for it is readily affected by the atmosphere, and, in decomposing, causes rocks which contain felspar and mica to decompose also, by setting free the alkalies.

Linnæus, in his classification of stones, speaks of calx or the earth of lime as originating from animal bodies, and by the presence of calx in polypes, he defined the divisions of the animal and vegetable kingdoms. In the state of nature, calx is whitish, absorbent, farinaceous when dry, penetrating, and effervescing with acids; it is elaborated in the living system of numerous genera of the ocean, and becomes a portion of the animal frame-work of many creatures of dry land, being abstracted from the earth, or entering the system through the medium of their food or drink. It is an elementary compound, generated by the direct action of light and heat, and mechanically uniting with the albumen and gelatine that form the basis or cement of the animal frame. It is a distinguished characteristic of animal life, being exclusively of animal nature, and is always found united with mucilage, gelatine, albumen, and other parts of the organic frame, forming bones, shelly coverings, and, in coral formations, stony concretions, resembling, in appearance and mechanical and vital action, fungi and other vegetable species of dry land; it is secreted in the stony madrepores much in the same manner as the constituents of the blood are generated in the higher orders of animals. Every limestone, chalk, oolite, marble, and other calcareous bed, owes its origin to this one common formation; many of them, as the mummellite hills of Egypt, and the shell limestones and marbles of this country, being wholly composed of tribes and families in aggregated masses; and although entire decomposition has obliterated all organic traces, still we have the certain facts before us, to identify the one and the other proceeding from the same source.

Having marked out to the student in natural philosophy the origin of limestone and of calcareous beds, I now direct his attention to that very important class of rocks and earths denominated siliceous, and previous to giving their practical application, must draw his attention to their origin, and of the changes consequent on climate and association.

Silicon is a compound of 8 parts of oxygen combined with 8 parts of the earth *silicium*, to form 16 parts of oxide of silicium, or silica. Sir Humphry Davy's experiments demonstrate that it is composed of a combustible body united with oxygen; for on bringing the vapour of potassium in contact with pure silicic acid heated to whiteness, a silicate of potassa resulted, through which was diffused the silicic acid in the form of black particles like plumbago. Thomson, Berzelius, and others, conceive it to be a non-metallic body. Berzelius tells us that if presented to water while in its nascent state, silicic acid is dissolved in large quantity; and on evaporating the solution gently, a bulky gelatinous hydrate separates, which is partially decomposed by a moderate temperature, but does not part with all its water at a red heat. In its chemical relations it manifests all the properties of an acid, and displaces carbonic acid by the aid of heat from the alkalies. Silica may be said to be the first generated product of all the earths composing this planetary body, the elementary constituents composing its basis being generated in and throughout the great scale of *life*, from animalculæ to the most complicated structure of man. It is almost the sole constituent of gelatinous animals, and a component part of the consolidated texture of all others, and is primarily manifest in the slime of oceanic animals and plants; it is elaborated by naked polypifers in a state of purity, is found as crystalline spicula in sponge, translucent as water in hyalonemidæ, and in tropical reeds and other land vegetable species.

Sands, which are thus produced by decomposition of the organic body, or by transition of the aggregate particles or entire bodies, are hyaline, without moisture, scintillant, of the same permanent hardness, and, united with other earths, fusible into glass: it accretes as

Sandstone.—In and throughout the ocean waters, the elaborated and elaboratory matter which forms the basis of silica is exceedingly abundant, generating and elaborating within the living system of animals and vegetables. The nature, form, and composition of the inorganic compound depends, of necessity, on the nature of the material of the compounds which form the animal or vegetable body, or otherwise on the nature and qualities of bodies with which it unites in the fossil and mineral kingdoms. In the lower depths of tropical regions, or in temperatures where naked polypifers and cold-blooded animals can exist, sands only are formed, unless other material is carried into these depths by the force of running streams, and these sands are of homogeneous qualities: thus, the lower depths are ever found to be composed of siliceous bodies, and sands and sandstone form the natural basis of all the undisturbed strata covering the superficies of the earth. The presence of iron, such as is manifest in the red sands and sandstones said to constitute the primary beds of the British strata, is demonstrable proof that these sands are of secondary qualities; for iron is not a primary product, but is elaborated within the system of animals of red blood, and is secreted in shallow, warm, and tranquil regions. Entering into the organic structure of many species, it is a secondary result. Mollusca and polypifers locate in groups and families in the various regions of the deep, and their nature and combined qualities, when the deposits are exclusively local, ever determine the nature and qualities of the sand. Thus, for instance, along the shores of the Red Sea, where the deposits, forming sea-beaches, are exclusively oceanic, various localities present varying phenomena of sands: some are formed entirely of young mollusca, almost invisibly minute in their particles; others are blended with the bodies, and fragments of bodies, of larger shell-fish, forming sands and pebbles; others are united with radiati, broken coral, and calcareous matter, varying in its mixtures—the accident of local disposition and of local union determining the result. In the decomposition of larger mollusca, the combined elements very often separate; the carbon and calx being carried away by occasional washings, the cartilaginous and outer epidermis separating as they mineralize into sands or siliceous bodies. This change is within the observation of all who choose to throw a common oyster-shell upon the earth, and leave it exposed to the action of the atmosphere for a season.

In general, the result depends upon the sum of local influences of heat and moisture. Within rainless regions, the larger mollusca thrown upon the shores, seldom decompose if thrown above the ordinary action of the waves; but they gradually consolidate, or rather become oxydated, the mechanical combination of their elements and atmospheric air being productive of the result. As they silicify, so the organic matter gradually disappears, the more delicate portions of the shell fall away, the protuberances separate, and in a very short time the main trunk of the animal becomes what is termed a petrifaction. If the shell become buried in moist sand it soon decomposes, and becomes one with the mass; if embedded in ocean marl, it also generally decomposes, unless arrested by local changes, the bed of marl being, by the circumstance of gradual change, abstracted from the dominion and influence of the waters. The shores of the British Isles can give little idea of the transformations taking place in distant lands, in composition and character widely dissimilar. Everywhere around England we behold the wreck of ancient strata: beds which have, age upon age, resisted the changing hand of time, washed by the ocean waves are rent asunder, their lighter particles being carried far into the bosom of the deep, their heavier aggregates remaining as barriers to further encroachments, or as warning to the inhabitants of the cliffs. Not so in other, and vastly more extensive, regions of the earth: it is true, the destroying hand is everywhere manifest, but the creative power is more sensibly and extensively exhibited; for the one locality, for the one solitary island, destroyed by the waters, thousands of miles are gradually abstracted from their dominion, and instead of the commingled phenomena of these, the older strata, which tell us of epochs of time, of revolutions and changes by flood or fire, we have phenomena peculiar to the waters above, and are enabled to mark their transitions into the fossil and mineral kingdoms.

Each region on the earth, or within the waters, varies in its capacities and in its tendency to generation, and maintains in its generations living creatures, having phenomena peculiar to itself, and common to all, the Causes of Effects, are therefore numerous. Every species propagates its kind, but the accidents of change of food, temperature, and association, may cause a change of organization. The like accidents of change are equally manifest in inorganic bodies, the mechanical or chemical union of one day giving place to the mechanical union of another day; the final disappearance of one mechanical mixture, causing another compound to make its appearance: but in all these changes, common to inorganic matter, we have not yet been enabled to note with correctness, how far silica changes in decomposition, and if it does so, under what circumstances this change takes place.

(*To be continued in our next.*)